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The New Luminous Arc Street Lighting System

A Paper read by Mr. H. W. Hillman before the Ohio Electric Light Association,
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THE Ohio Electric Light Association has always recognized the importance of the arc lighting branch of the electrical industry. Each year its meetings have been favored with one or more articles on the subject, together with interesting discussions referring to details. I had the honor of reading one of the first papers before this Association, referring to the Series Alternating System of Street Lighting, and as the years have passed on, opportunity has been afforded to see the results secured from that system in actual practice. I believe that we are all of one mind, that the series alternating system has not only "made good" throughout the State of Ohio, but it has been established in the entire country as an eminently satisfactory street lighting system.

It is my pleasure at this meeting to first introduce the new Luminous Arc for street lighting service. For several years the General Electric Company has been experimenting with electrodes, and with old and new forms of lamps for operating same. These experiments were confined for a period of two years to the Laboratory, and then nearly two years were taken in the commercial test and introduction of the complete system.

Evidence is now available to the effect that the system is commercially satisfactory. At Jackson, Mich., 300 Magnetite Lamps have been operating since May 15th, a period of three months. At Portland, Ore., a trial system was installed without a man to operate it. It was desired to ascertain if a new system could be sent from a factory in the extreme East, to a central station in the extreme West, and operate satisfactorily with the ordinary attention of the arc lighting foreman of the lighting company. For four months the Portland system has been giving satisfactory service.

Another contract has been closed for 800 lights capacity, after a trial system had been operating three weeks. The city authorities were well satisfied with the light, and the operation of the system was such as to satisfy the central station people. Time permitting, I could give many more evidences that the system is commercially satisfactory for central station use and for the purpose of making attractive and satisfactory city contracts.

BRUSH MACHINES FOR LUMINOUS ARC SYSTEM

The system includes a Brush machine, a new type of arc lamp, and a new type of combination hanger and cut-out. Describing them briefly, the Brush machine is well known to the members of this Association. Instead of being wound for 9.6, 6.6, or 5 amperes, it is wound for a 4 ampere current. It possesses the same mechanical advantages which years ago established its reputation. It has the oil type of regulator, which has been well tried, and found satisfactory; also the multi-circuit arrangement, with which you must all be familiar. It has an output of 11,250 volts, accommodating approximately 135 Magnetite Lamps operating at rated standard current and voltage.

NEW COMBINATION HANGER AND CUT-OUT FOR LUMINOUS ARC SYSTEM

Before taking up the Luminous Arc Lamp, I want to call particular attention to the subject of Combination Hangers and Cut-Outs. Very little has been said on the subject in the past, and it is the last device which a station manager investigates when considering a new system. Notwithstanding, it is one of the most important features of an arc lighting system. Even a new Magnetite system might be judged unsatisfactory because of a poor cut-out. It is not infrequent that a lighting company will spend \$15,000 to \$20,000 for a new enclosed arc lighting system, and leave the old type hanger boards in the same place where they have been

doing service for more than 10 years. In one instance, I recollect that a station manager refused to consider replacing his old hangers, and commenced to operate 400 new series alternating lamps with the same old cut-outs. Within a month, one of the boards caught fire one night, caused a blaze in the street, and allowed the lamp to drop to the ground. As soon as possible, thereafter, 400 new cut-outs were installed, and the accident has never been repeated.

An engineer of considerable prominence recently condemned a hanger because the separate insulator attached to it was made of glass. It was claimed that an individual (probably a boy), with a shot gun, could break the glass insulator, and allow the lamp to drop to the street. After this report, a dozen or more cut-outs with lamps, were hung up in the woods, and an expert rifle shot was sent out to destroy the glass insulators. From his test, it was found possible for the lamp to drop if the insulator should be struck at a very particular point, but it would take a crack rifleman, instead of a boy, to accomplish the feat.

Notwithstanding, all these detailed points have been gone over, and the very heart of the subject has been reached. Recommendations can be summed up in a few words:

1. Old hanger boards and cut-outs should be discarded with the old open arc system.
2. The insulation cannot be too strong. The cut-out recommended with the Luminous Arc System is tested for a potential strain of 40,000 volts dry, and 20,000 volts wet, thus assuring a very high safety factor against potential strains.
3. The cut-out should be mechanically perfect. The hooks should be able to stand at least a dozen times the weight of the lamp. Where hooks support the weight of both hanger and lamp, the parts should be so constructed that in case of breakage from stones thrown by boys or breakage from rifle shots, the lamp will still be supported without dropping. Even though all the surrounding parts of the insulator and cut-out are broken away, the metal hooks should be incapable of breakage, and still support the lamp. Electrical engineers, central station managers, and manufacturers are making special efforts to have the development of hangers and cut-outs keep pace with other improvements in arc lighting devices, and I have not hesitated, therefore, to dwell in detail on this subject.

NEW TYPE LUMINOUS ARCS

As an arc, it represents one of the most wonderful developments in the history of the art. If it possessed simply the advantage of higher efficiency, with disadvantages in other respects, I can easily imagine there would be no little demand for it. The facts, however, show that the Luminous Arc possesses other and additional advantages and qualities, superior to any commercial arc previously designed. Some of the essential advantages may be discussed as follows:

1. Character of the arc; horizontal distribution of light.
2. Volume of light; illumination ratings.
3. Steadiness and uniformity in burning.
4. High efficiency, energy, and maintenance economy.
5. Correct color for city street lighting.

You are all familiar with the character of the open arc; over 90 per cent. of the light comes from the crater at the tip of the upper carbon. The negative end burns to a point, and the maximum light distribution is well known to be at an angle of 45 degrees. For several years the light distribution from the enclosed arc has been presented as superior to the open arc, because the arc is long. The carbons burn flat at the ends, and the light is distributed nearer the horizontal direction than the open arc. More light comes from the arc itself in the enclosed type, compared with the open; but the character of the luminous arc is distinctly superior to either of the two mentioned.

The luminous arc is solid, or thick. The arc itself is filled with light. All the light comes from the arc; hence it is called the Luminous Arc, as distinct from the Open Arc, in connection with

which so much light comes from the crater, and very little from the arc itself. As the length of the luminous arc is ten times the length of the open arc, and two or three times the length of the enclosed arc, splendid opportunity is afforded for the best light distribution at a horizontal direction.

VOLUME OF LIGHT — ILLUMINATION RATINGS

The Luminous Arc gives an effective illumination about 30 per cent. greater than the Enclosed Arc — either series direct or series alternating. The average luminometer reading shows that the direct enclosed arc with 480 watts at terminals, gives a 257 foot rating. The series alternating enclosed arc with 480 watts, same energy, gives practically the same illumination, or a 247 foot rating. In comparison, the luminous arc shows an average luminometer reading of 325 feet, or practically 30 per cent. greater than the very best enclosed arc, commonly used in commercial practice.

Authentic luminometer readings have been almost impossible to secure in respect to Open Arc Lamps. Some years ago, the method of candle-power ratings was discouraged, and almost universally discontinued. The method of rating illumination by energy in watts consumed is not now accurate, inasmuch as the new Luminous Arc Electrodes with much less energy produce more light than was possible with open arcs. The open arc lamps are operated in practice with an open globe, subjecting the naked arc to the influence of wind and rain storms, as well as to bad effects from dust and dirt. Open arc globes are commonly dirty, and not well kept. Frequently small sized old style arc machines are overloaded, and on account of the many disadvantages under which existing open arcs are operated, it is very easy to show superiority in effective illumination of the Luminous Arc, compared with the Open Arc. All open arcs throw a distinct shadow in common practice, and in maximum and minimum luminometer readings, vary so much that the light is not as uniform, or as steady, as that from the luminous arc. Particular attention is called to the maximum, average, and minimum luminometer readings from the luminous arc, which prove that the light is uniform, effective, and reasonably free from the variation of the open arc, or the wandering of the enclosed arc.

HIGH EFFICIENCY, ENERGY, AND MAINTENANCE ECONOMIES

Considering the volume of light, and the low energy of 300–320 watts at terminals, the efficiency of the Luminous Arc System is high, and the energy economy at one cent per kilowatt-hour, operating 4000 hours per year, is noticeably large. The new Brush machines have been improved, in respect to their pole shoes and the addition of windage screens, so that an efficiency of 88 per cent. can be secured. The electrode life of the lamp is 150–175 hours, so that from the standpoint of maintenance, the Luminous Arc Lamp is fully on a par with the Long Burning Enclosed Arc. There is a marked saving in the luminous arc lamp, compared with the open arc, due to the long burning feature, as has been illustrated during several years' experience with enclosed arc lamps.

CORRECT COLOR FOR STREET LIGHTING

Those who have seen the light are pleased with its color. Much time was spent in the laboratory to secure a light having a spectrum like the daylight spectrum. A great deal could be said on this particular phase of the subject, but briefly, the light represents the highest degree of whiteness of any artificial light in commercial service today.

THE LUMINOUS ARC LAMP

It was necessary to design a new type of lamp to satisfactorily operate the new electrode. Neither an ordinary open arc, nor a later type enclosed arc would answer the purpose. The

General Electric Company therefore developed a lamp about two or three years ago, at its Lynn Works. Exhaustive tests were made, first in the laboratory and factories. Six months later, or two years ago, a trial system was placed at Schenectady on the streets. After seven months the lamp was improved, and 25 Form 2 Lamps were sent to Newton, Mass. About eight months later, these lamps were operated with reasonably good results, and then changed to the Form 3 Lamp, which is now in commercial service, and for which large orders have been and are being taken.

The lamp operates at 4 amperes, and 75-80 volts at the arc. It is equipped with the usual cut-outs essential to a series lamp. The fumes, which are indigenous to the electrode, are carried away by a chimney extending from the base of the lamp to its top. On the upper portion of the chimney, a wind shield is located for the satisfactory operation of the lamp during severe wind storms. With some of the first type of lamps, neither the wind shield nor the chimney were effective. As a result, dust collected in the chimney, discoloring the outer globe, and the wind caused an annoying flickering of the arc. These defects have been remedied.

A distinctive feature of the lamp is its design, with but one renewable electrode. The upper terminal is a permanent part resembling a clutch, and is quickly replaceable after it is worn away. Experience has not been sufficient to determine the life of this part; it may require renewal at least twice a year — possibly three times. In any event, it is not a serious account for maintenance, because the renewal will not be excessive in cost, and only one consuming electrode is required, instead of two carbons, as in the past.

An automatic lowering device makes the trimming very convenient. By pressing a button, the electrode holder drops through an opening in the globe, and the electrode can be quickly and easily renewed. The outer globe is rigid, and does not require removal, raising, or lowering. This method saves time, and effects convenience.

BRIEF COMPARISONS WITH OTHER FORMS OF LAMPS AND OTHER SYSTEMS

The Multiple 220 Volt Enclosed Arc has always been considered a partial success only. Frequently the advantage of multiple service led the purchaser to accept the violet light secured from the long arc. The Luminous Arc can be placed in multiple across a 220 volt service, producing a pure white light, bountiful in volume. The lamp can be wound for the same energy as the enclosed arc, thus securing the advantage of many times the amount of light; or the energy can be decreased, thus taking the advantage in the form of a saving of energy for the same amount of light.

The operation of five enclosed arcs in series on a railway circuit, or a 500 volt power circuit, has been considered very satisfactory. The luminous arcs can be operated from the same service. No essential advantage is gained, unless the additional volume of light produced per lamp is particularly desired.

The luminous arc has not been designed for interior service, nor has it been designed to operate on a so-called 110 volt constant potential circuit; nor on an alternating service. Possibly before your next annual meeting a more encouraging statement can be made in this respect.

Comparing the Luminous Arc Street System with the Series Direct Enclosed Arc Street System, the advantages of the former are remarkable in every way. The saving in energy is represented by 320 watts, as against 480 watts, with an increased efficiency of the new Brush machine, and 30 per cent. more light. Wherever a change is being considered in connection with street lighting, the future will never again offer a good reason for installing series direct enclosed arc lamps.

Comparing the Luminous Arc Street System with the Series Alternating Enclosed Arc System, each case must be considered specially, with regard to the station conditions. Where alternating generators have been purchased and installed with a definite plan of later operating the series

alternating system, it would appear unwise to install the luminous arc system with Brush machines. Where large size Brush machines are now installed, and the subject under consideration is simply the change of the arc lamps, it is an easy proposition to rewind the machines for 4 Ampere Luminous Arcs, and less expensive than it would be to install the series alternating system. Where the frequency is below 60 cycles, necessitating the purchase of motor-generator sets to secure 60 cycles for the series alternating system, it is cheaper to adopt the Luminous Arc System with the other advantages which it possesses, of high efficiency, steady operation, ample volume of light, best distribution, and correct color.

COMPARISON OF LUMINOUS ARC WITH HIGH EFFICIENCY FLAME ARCS

During the past two or three years much has been said and written in regard to foreign types of Flame Arcs. Circulars were printed and distributed in regard to the Bremer Arc. A few sample lamps have been installed. The claims for these flame arcs refer particularly to the volume of light produced, or the high light efficiency of the arc. To secure the high light efficiency it was necessary to use a high current, and a short burning lamp. In no case were such lamps ever presented with the long burning feature, and with low energy consumption.

In closing, therefore, I emphasize the point that the electric lighting companies in the United States are still far in the lead with respect to arc lighting systems. The central stations of this country have always been leaders in respect to arc lighting systems. The enclosed arc lamp particularly emphasized this fact, and the series alternating street system further proved it. Today, with the introduction of the new Luminous Arc System, there is evidence that we shall remain leaders for many years to come, and so long as the Ohio Electrical Association continues to take the aggressive interest in arc lighting matters it has taken in the past, the central stations in the State of Ohio will remain in the front ranks with respect to arc lighting progress. Ohio has been first in furnishing Presidents for the United States. It is always first to investigate and adopt the newest and latest arc lighting system.

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